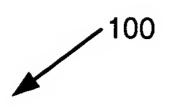
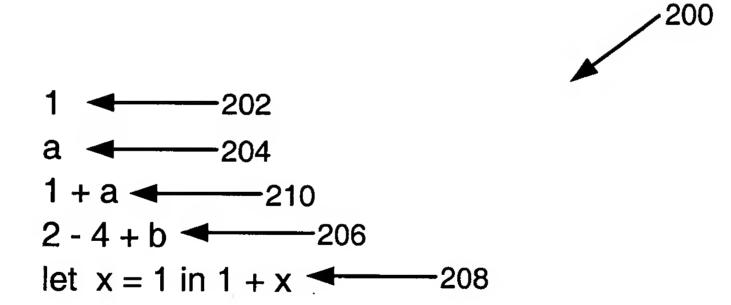
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FIG. 1





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FIG. 3

```
abstract structure Exp ←
 case Const ←
 val as Integer case Bin ◀
                  -308
  op as Op
  left as Exp ←
  right as Exp ←
 case Let ◀
  name as Name
  def as Exp
  body as Exp
 case Var
  name as Name
enum Op
 Add
 Sub
type Name = String
```

FIG. 4

```
structure Exp
public override ToString() as String?
match me
    x as Const:
    return ToString(x.val)
    x as Bin:
    return "(" + x.left + ToString(x.op) + x.right + ")"
    x as Let:
    return "(let " + x.name + "=" + x.def + " in " + x.body +

    x as Var:
    return x.name

ToString(o as Op) as String?
match o
    Add: return "+"
    Sub: return "-"
```

/300

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FIG. 5

Closed(e as Exp) as Boolean Closed(e as Exp, ns as BoundedNames) as Boolean match e ← -502 Bin(_,l,r): return Closed(l, ns) and Closed(r, ns) ← Let(n,d,b): return Closed(d, ns) and Closed(b, ns + {n}) Var(n): return n in ns ← 506 -518 508 514 516

FIG. 6

Eval(e **as** Exp) **as** Integer require Closed(e, {}) return Eval(e, {->})

Eval(e as Exp, env as Environment) as Integer require Closed(e, Indices(env)) match e Const(v): return v
Bin(o,l,r): return Eval(o, Eval(l, env), Eval(r, env))
Let(n,d,b): return Eval(b, env + {n -> Eval(d, env)}) Var(n): 'return env(n)

type Environment = Map of Name to Integer

Eval(o_as Op, I as Integer, r as Integer) as Integer · match o

Add: return | + r Sub: return I - r

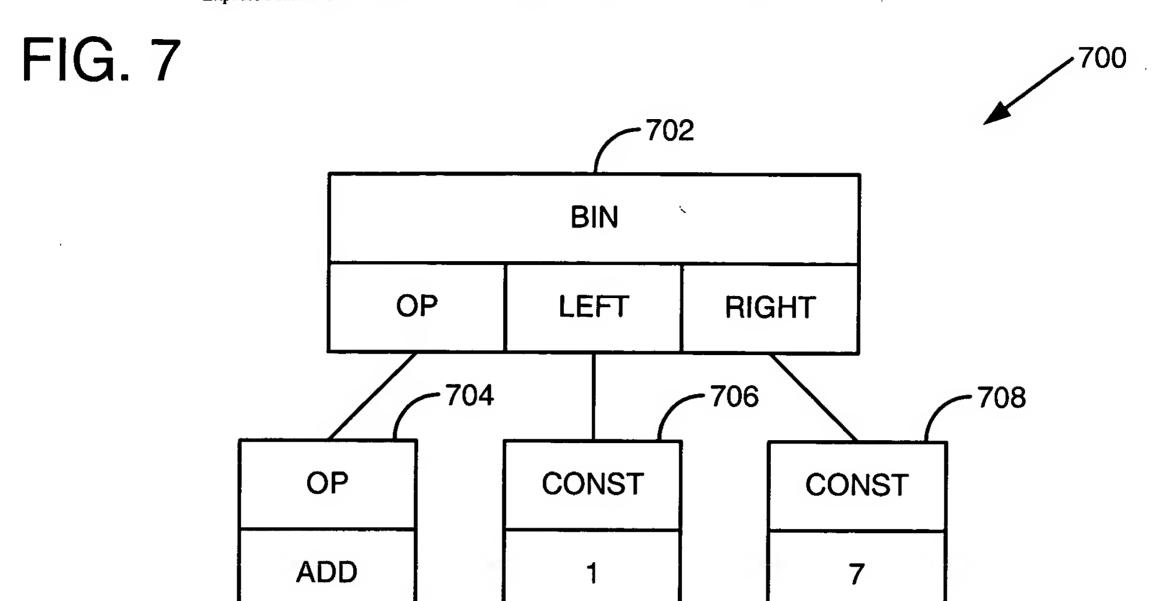
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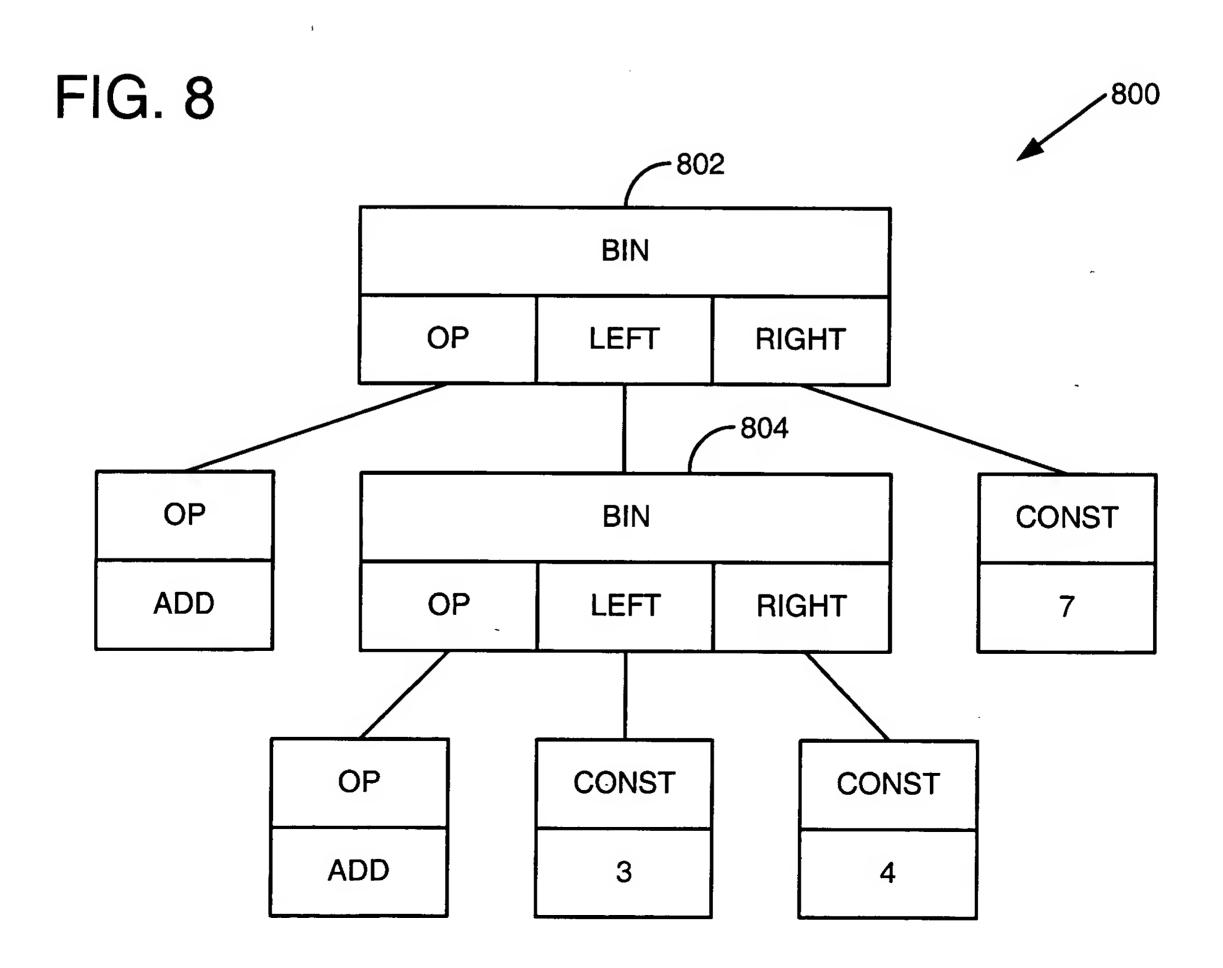
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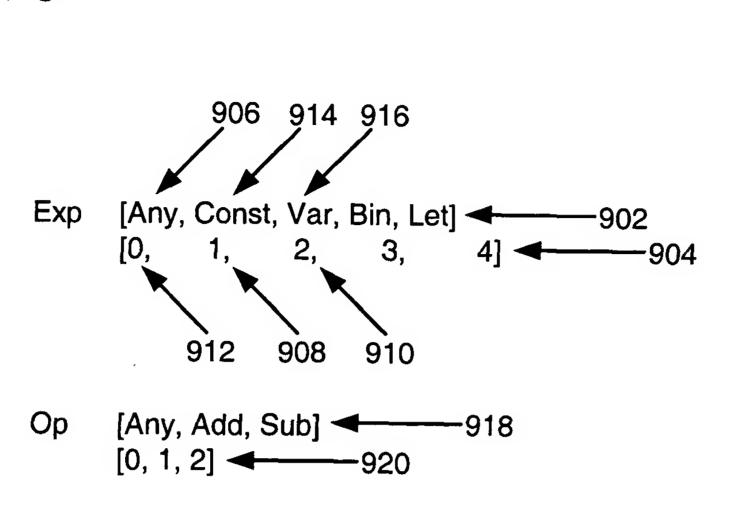
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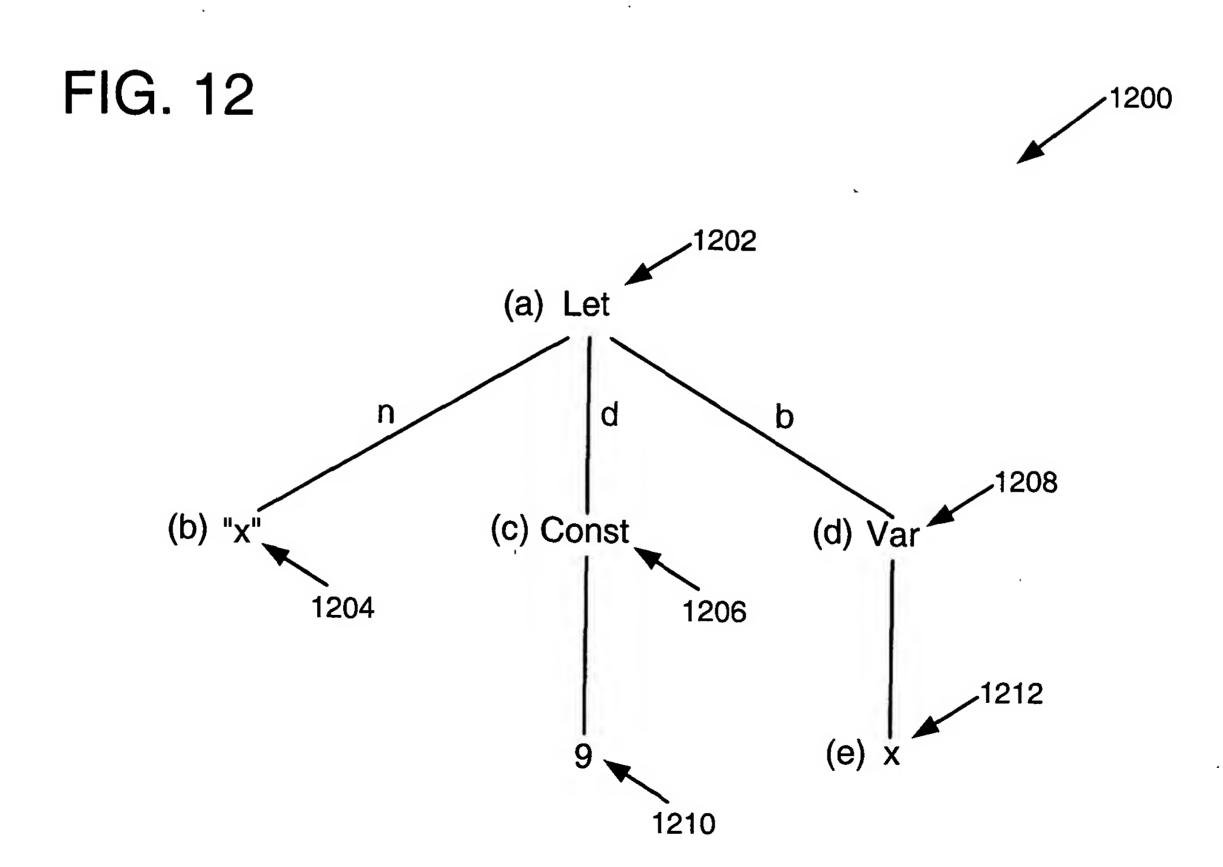
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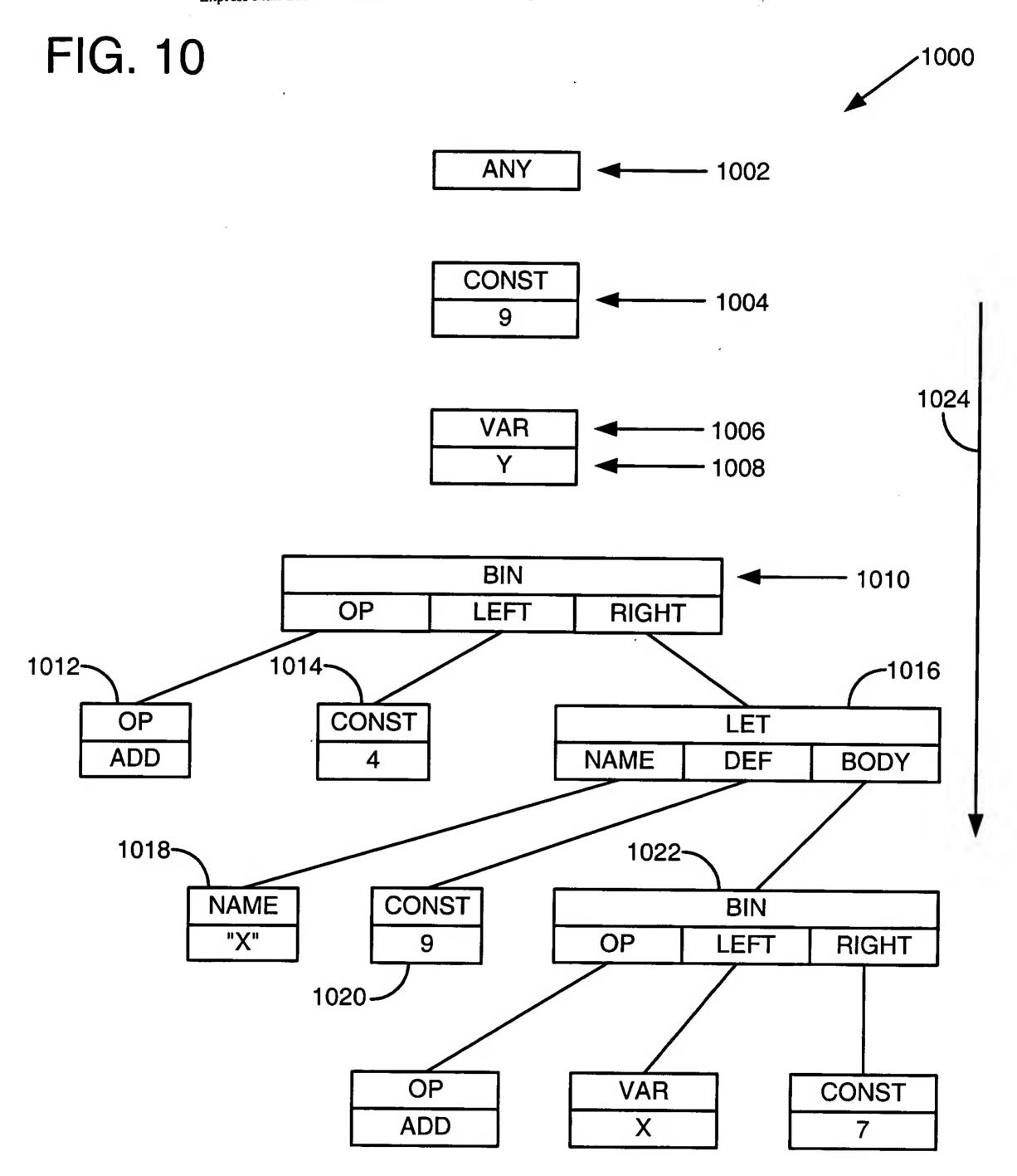
FIG. 9





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/110	00

	/1102
BIN	

<u>OP</u> 0	<u>VALUE</u> ANY	<u>LEFT</u> 0	<u>VALUE</u> ANY	RIGHT	<u>VALUE</u> ANY
0	ANY	Ö	ANY	1	CONST
0	ANY	0	ANY	2	VAR
0	ANY	0	ANY	3	BIN
0	ANY	0	ANY	4	LET
0	ANY	1	CONST	0	ANY
0	ANY	1	CONST	1	CONST
0	ANY	1	CONST	2	VAR
0	ANY	1 ′	CONST	3	BIN
0	ANY	1	CONST	4	LET
•		•	•	•	•
1	ADD	1	CONST	1	CONST
1	ADD	1	CONST	2	VAR
•	•	•	•	•	•
2	SUB	4	LET	3	BIN
2	SUB	4	LET	4	LET

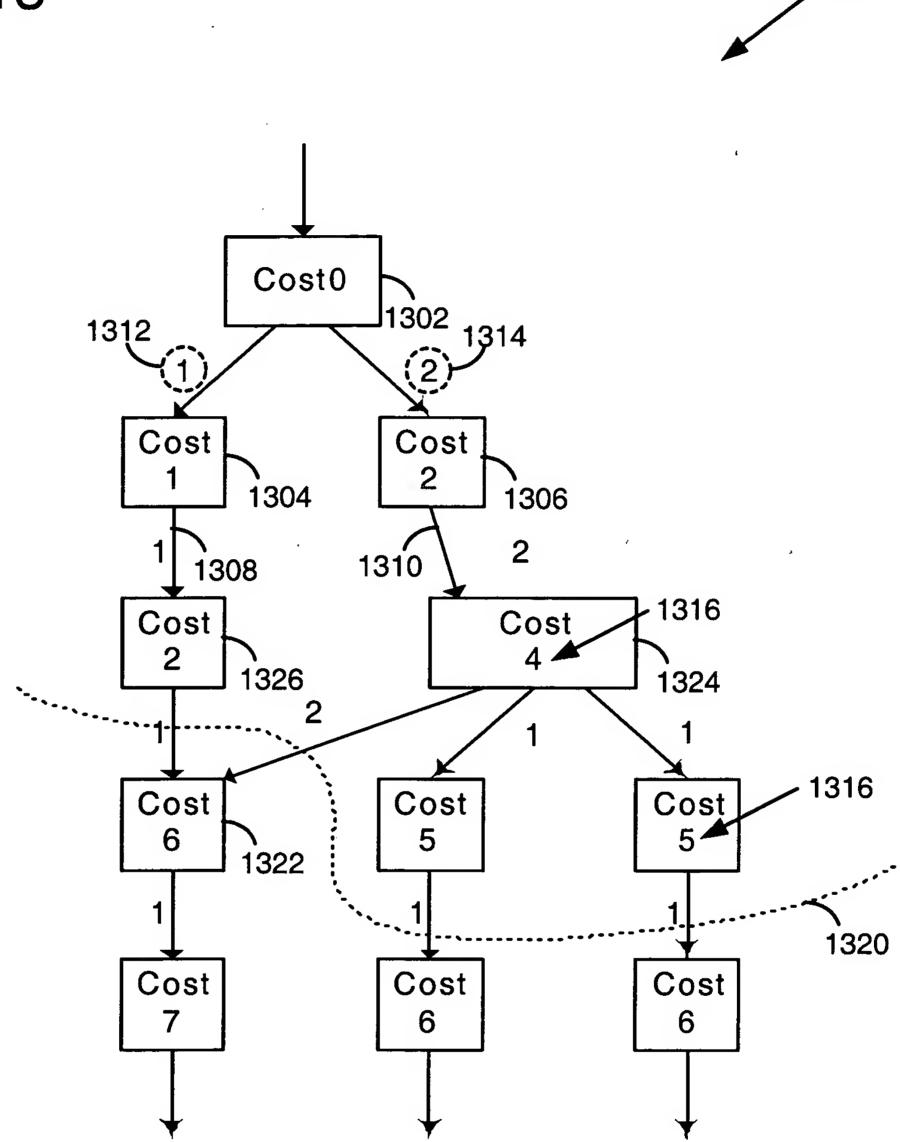
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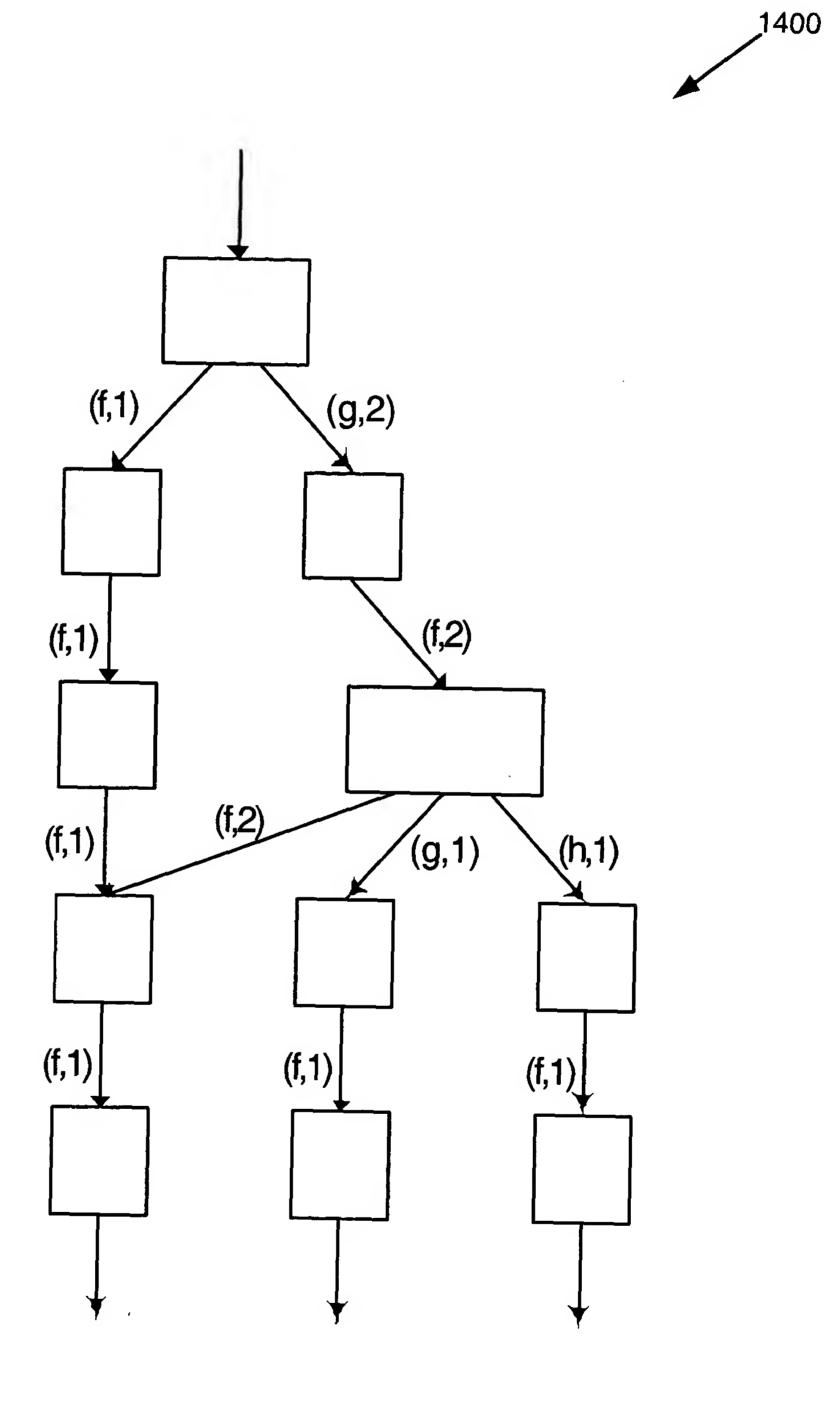
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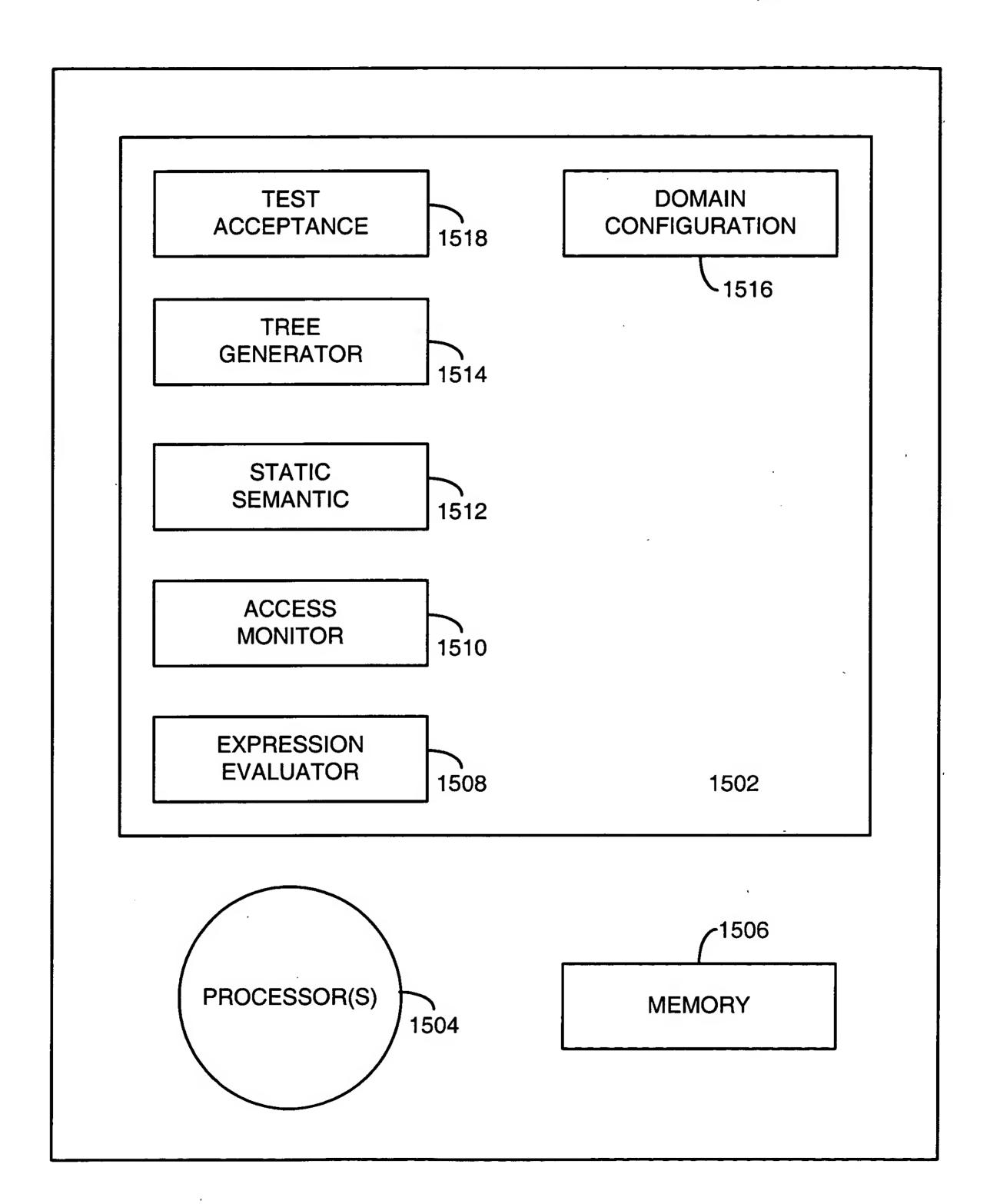


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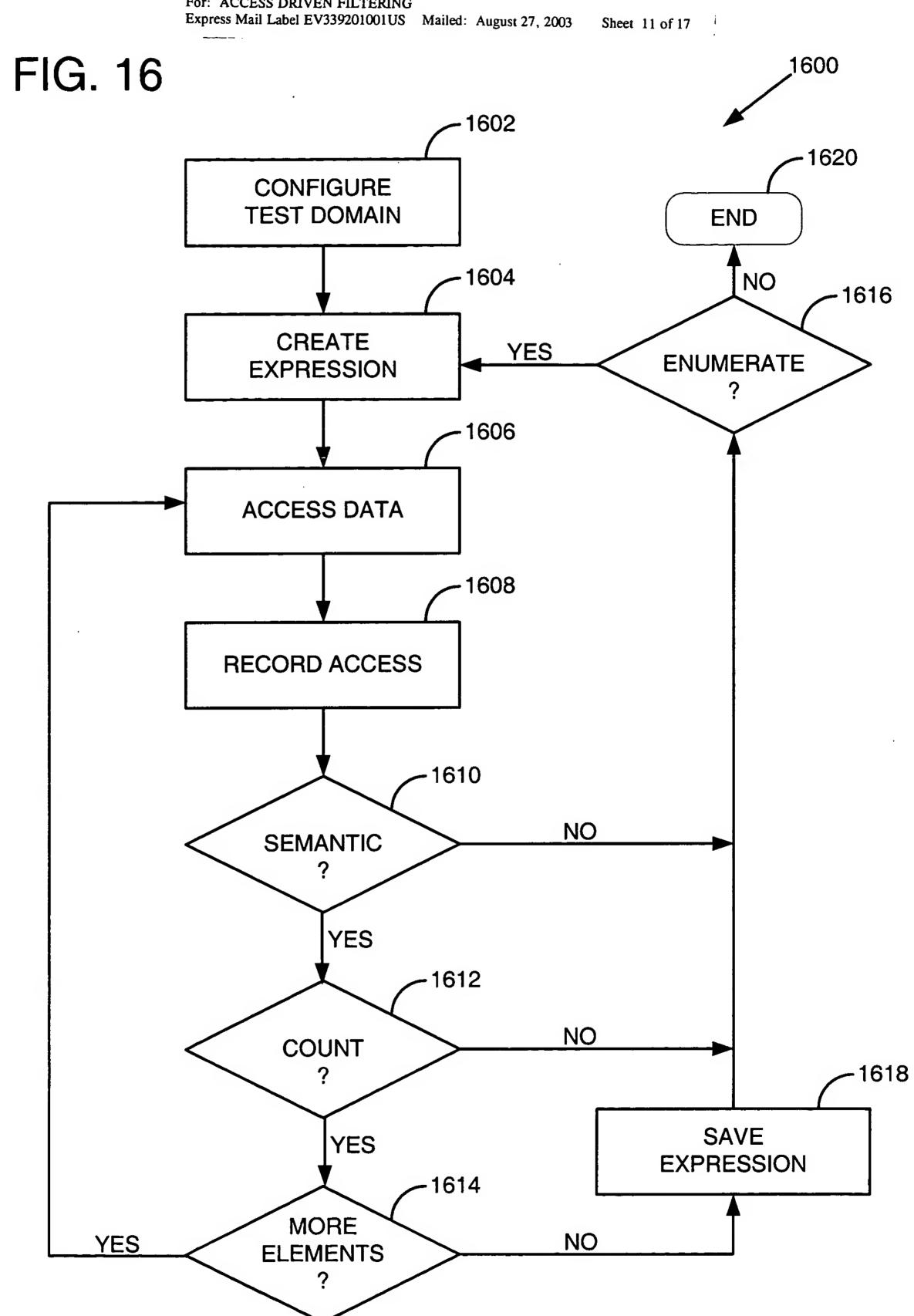




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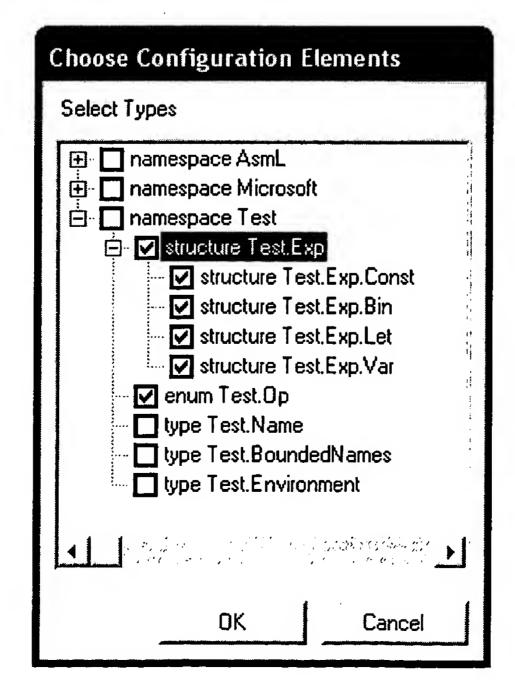
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FIG. 17

```
abstract structure Exp
 case Const ~ 1710
 val as Integer 1711
 case Bin 1720
 op as Op 1721
 left as Exp 1722
 right as Exp ~ 1723
 case Let _____ 1730
 name as Name ~ 1731
 def as Exp 1732
 body as Exp 1733
 case Var 1740
 name as Name 1741
enum Op
              1750
Add
 Sub
```

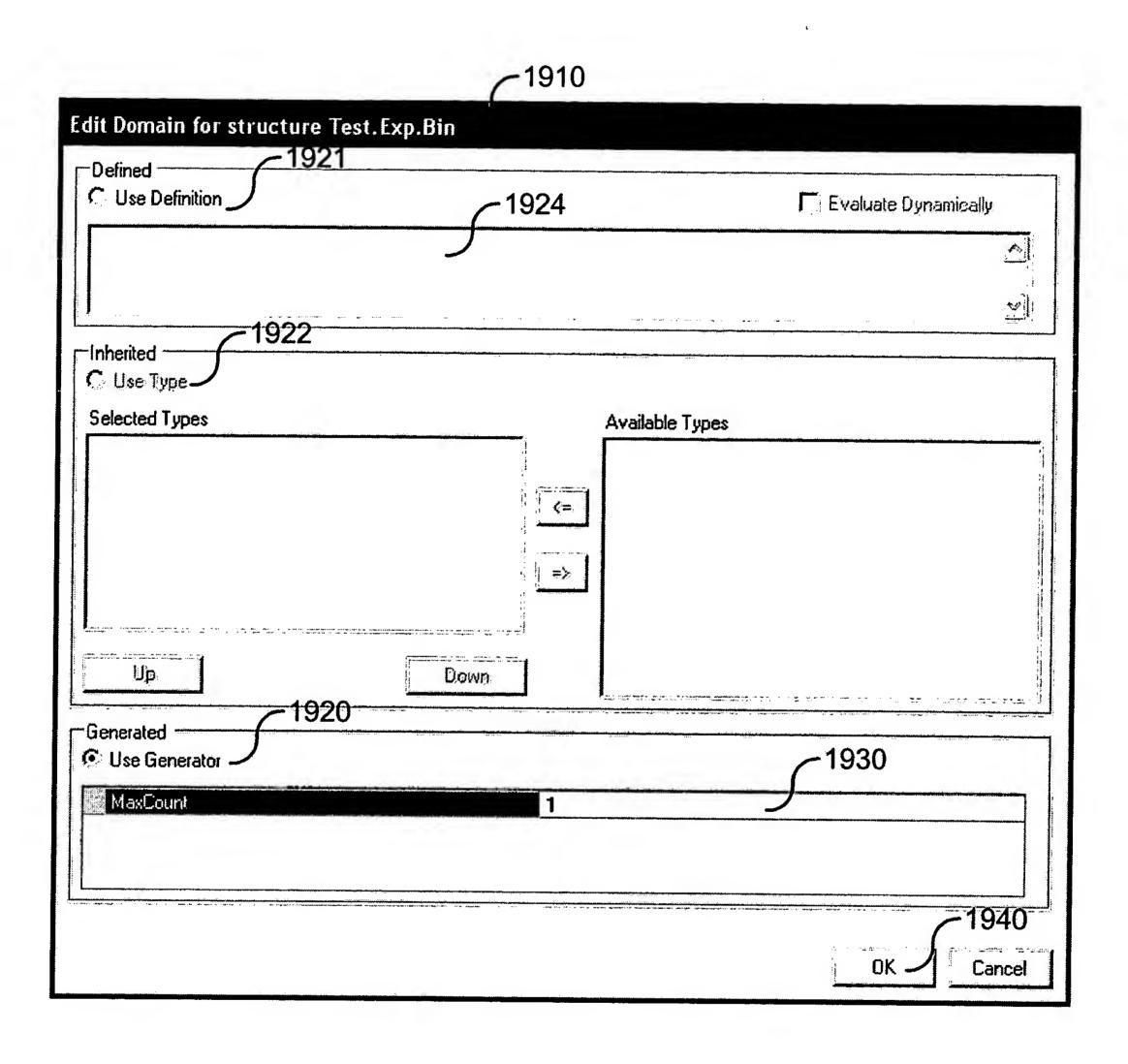


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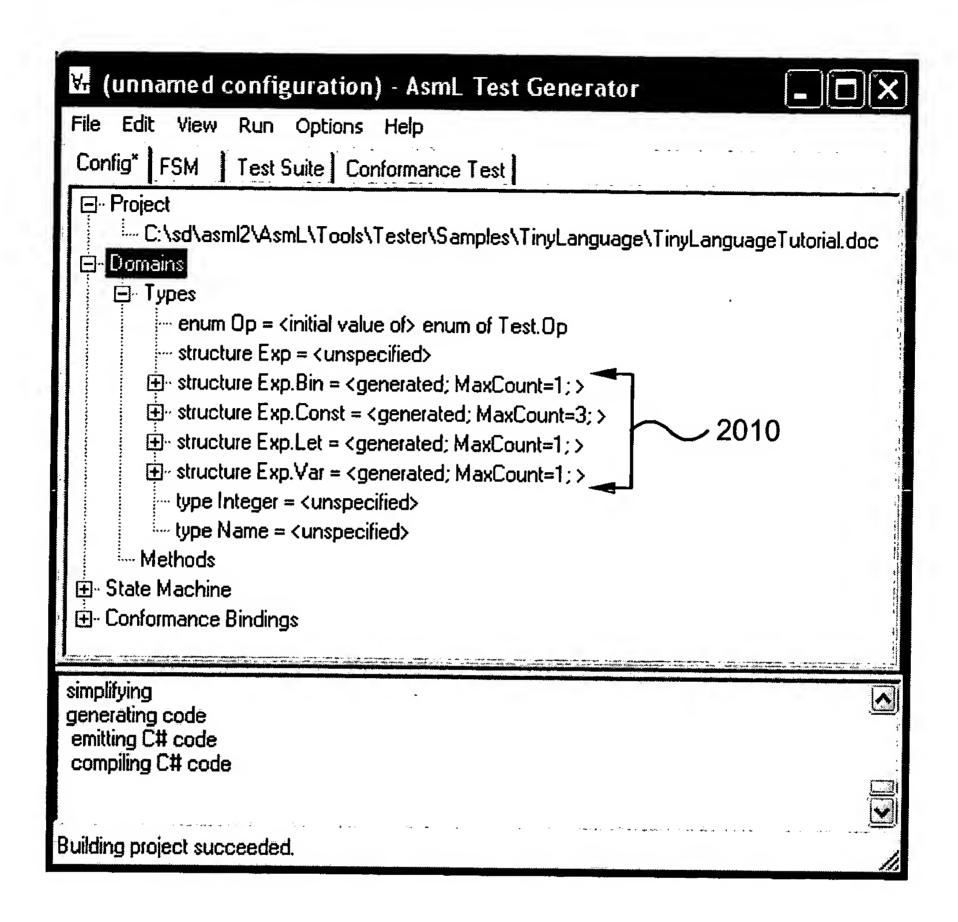
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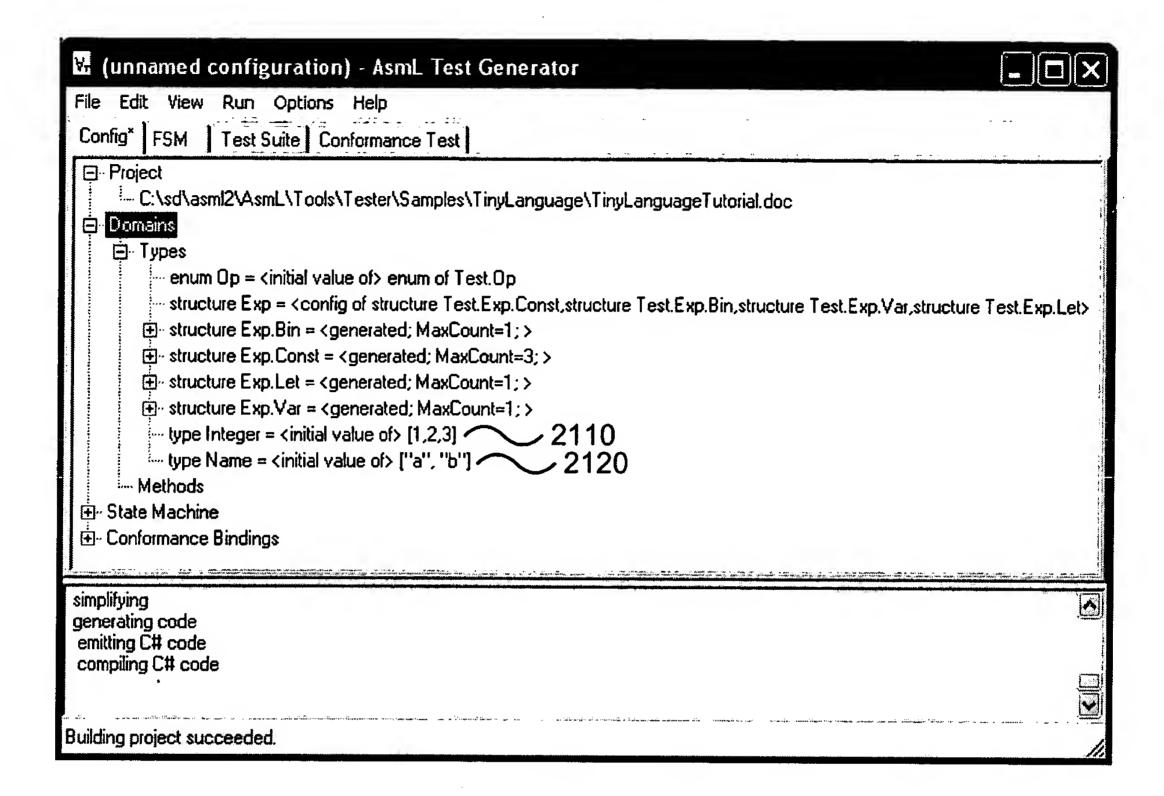
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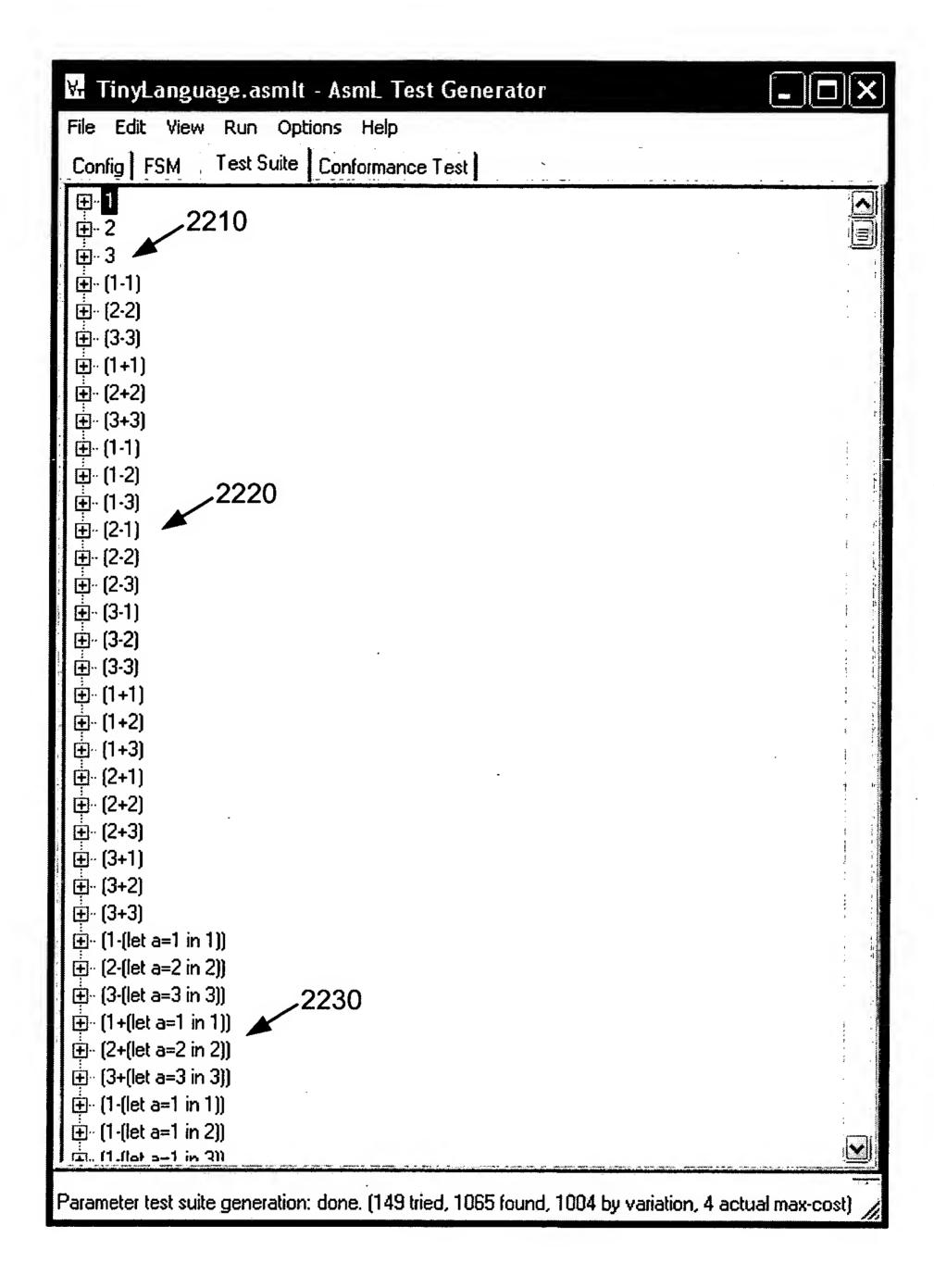
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FIG. 23

